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ABSTRACT

The purpose of this study was to explore science teacher decision-making with students of diverse populations. The research site was a suburban middle school located in the southeast. The student body consisted of African Americans, Caucasians, and international students from 62 different countries. Extensive social contextual research was performed. Case studies of two science teachers, a veteran White female life science teacher and a first-year White male earth science teacher were conducted over an extended time. The teachers, their students, a student teacher, and key informants from the school and the community participated in extensive formal interviews throughout the study period. Participant observation and videotaping data collection strategies were used to collect data in the science teachers' lessons throughout the study period. Analytic induction and the constant comparison technique were used to analyze both textual and videotaped data. Findings focused on an analysis of the teacher's decision-making conducted before, during, and after instruction. Analytic constructs describing each teacher's decision-making were constructed. The key finding was that the teachers did not believe that consideration of their students' diverse cultural backgrounds should be included in their decision-making. The students' diversity was extolled in the social sphere; in the teaching sphere it was excluded. (Author)

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# Science Teacher Decision-Making In Classrooms With Cultural Diversity: A Case Study Analysis

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**Abstract**

The purpose of this study was to explore science teacher decision-making with students of diverse populations. The research site was an suburban middle school located in the Southeast. The student body consisted of African Americans, Caucasians, and international students from sixty-two different countries. Extensive social contextual research was performed.

Case studies of two science teachers, a veteran White female life science teacher and a first-year White male earth science teacher were conducted over an extended time. The teachers, their students, a student teacher and key informants from the school and the community participated in extensive formal interviews throughout the study period. Participant observation and videotaping data collection strategies were used to collect data in the science teachers' lessons throughout the study period.

Analytic induction and the constant comparision technique were used to analyze both textual and videotaped data. Findings focused on an analysis of the teacher's decision-making conducted before, during, and after instruction. Analytic constructs describing each teacher's decision-making were constructed. The key finding was that the teachers did not believe that consideration of their students' diverse cultural backgrounds should be included in their decision-making. The students' diversity was extolled in the social sphere; in the teaching sphere it was excluded.

## Introduction To Study

In 1981, Shavelson and Stern asserted that teachers act as professionals and independent thinkers, who are constantly making decisions in an uncertain and complex environment. Influenced by that assertion, science education researchers such as Olson (1982), Aikenhead (1984, 1989), and Duschl and Wright (1989) established a science teacher decision-making research program. In this present study, the focus was on an unexamined, but critically important area: science teacher decision-making in culturally diverse classrooms.

In this study, a description of the decision-making (D-M) of the two participant science teachers, pseudonymous Mrs Guide and Mr Green, performed before, during, and after teaching their culturally diverse students their respective sciences, seventh grade life science and eighth grade earth science is presented. The research site was pseudonymous World Middle School (WMS). In addition to White mainstream students and African Americans, the student body also had significant representation from sixty-two different countries.

For heuristic purposes in this paper, the structure of each teachers' decision-making is presented in a sequential order within the three broad categories of before, during, and after teaching. Teacher decision-making is a dynamic process that occurs continuously throughout teachers' days. It is typical for teachers to make decisions within one category while considering components of the other categories. The definition used in this study of decision-making is the process of using judgment to make choices between perceived pedagogical alternatives.

## Methodology and Data Sources

The research methodologies used in this study were qualitative (Erikson, 1986). Data sources for decision-making before and after instruction were transcribed participant teacher interviews and participant observation field notes taken before and after science instruction. Data sources for during-instruction D-M were field notes taken during science teaching observations, videotaped Teaching Practice Critical Incidents (TPCI) recorded during instruction, and teacher reflections of the TPCI.

## Science Teacher Decision-Making Literature Review

In the 1980s, after quantitative research studies conducted the decade before in decision-making had reached an impasse due to "problems generating matrices of conditional probabilities" (Shulman & Elstein, 1975), qualitative research methodologies were applied in investigations of teacher decision-making. In science education, three major qualitative studies on teacher decision-making were conducted by Olson (1982), Aikenhead (1984), and Duschl and Wright (1989).

Olson (1982) investigated science teacher decision-making in situations where teachers were instructed by their administration to implement a new science curriculum. From the qualitative data from eight science teachers in three comprehensive schools, he found that teachers face "dilemmas" in taking action (p.141). He referred to these dilemmas in teaching as

> analyzable into dichotomies which are inherent in actions. ...the fruits of the logical reconstructions of peoples' behavior" (p.14). [Science teachers faced the dilemma of] balancing goals, techniques, and social relationships while implementing an inquiry science curriculum (p.166).

Olson argued that it was through the understanding of teacher dilemmas that educators could attempt to understand the choices that teachers make. To do that Olson stated

> we must consult the views of the teachers....We have to know the system as a whole, if we are to understand the meaning of the act" (p.10).

Aikenhead (1984) explored the decisions science teachers make when they plan for instruction, which he called "pre-active" decisions, as opposed to the "interactive" decisions made spontaneously in classroom during instruction (Jackson, 1968). He conducted a case study analysis of five science teachers in a high school.

Aikenhead portrayed the ways high school science teachers draw upon their values in making pre-active decisions from the teachers' perspective. Aikenhead's strategy for data gathering followed a clinical supervision cycle in which the researcher was present in three different stages: planning instruction, observing the instruction, and analyzing the instruction after instruction (Shavelson & Stern, 1981). Aikenhead modified the third stage to focus entirely on the pre-active decisions made. He discussed with the teacher

> the decisions that had led to specific classroom events, the reasons behind those decisions, and the teacher's perception and beliefs that warranted those reasons" (p.170).

Aikenhead also interviewed school administrators, attended school meetings, and read student laboratory reports and examinations. He found that the teacher interviews that dealt with dilemmas frequently yielded exceptionally rich data.

Aikenhead concluded that teachers made decisions based on personal reasons, beliefs, and dilemmas (Aikenhead, 1984). Aikenhead asserted that teachers' decisions were based on their perceived need to prepare students for the next level of education, an "ethos or rigor" (p. 177) defined by the need for quantitative problem solving, a need to exercise some control over the curriculum, and a belief that students should be socialized by school experiences.

The pre-active decisions represented the end result of the conflict between a cluster of teacher intentions and practical ideas about student characteristics. Through compromises and tradeoffs, the science teachers generated an "equilibrated network of reasons for each decision they made...." (p.184).

The implication of Aikenhead's study was that the beliefs science teachers held of their academic discipline combined with their practical teaching experiences created a robust framework resilient to change from curriculum innovators and education researchers. As a consequence, Aikenhead advocated the role of teachers as co-researchers in curriculum development, as opposed to the traditional role of teachers as recipients of new curricular materials.

Duschl and Wright (1989) focused on the manner and degree to which science teachers consider the nature of the subject matter in their decision-making involved in "the planning and the delivery of instructional tasks" (p.1). The goal of their study was to develop a grounded hypothesis about science teachers' pedagogical decision-making from a theoretical framework of information-processing. The researchers posited that in the complex world of teaching, teachers attempting to cope with the large amount of stimuli, "construct models of reality upon which decisions are based" (Duschl & Wright, 1989, p.2). Specifically, they wanted to determine the extent of considerations of the nature of the subject matter in teachers' decision-making.

The study site of Duschl and Wright's investigation was one science department in one suburban high school located outside a major Atlantic city (pseudonymous Comprehensive High School). The period of data collection was sixteen weeks, or one

semiester. The research methodology was ethnographic. There were sixteen participants in the study (the entire science faculty in the school). Specific data sources included field notes, audio-tape interviews, teacher surveys, and documents.

One general finding in the study was the prevalence of the teacher-student bond, referred to as "humanistic ownership" (p.13). That label reflected the sentiment teachers have for the students they are assigned. It was also pointed out

> Teachers of earth science and biology see a very different population of students than teachers of chemistry, physics, and advanced biology (p.14).

Their findings relevant to teacher decision-making was that the teachers did not consider the essence of the subject matter as a component of their decision-making. This contradicted Shavelson and Stern's (1981) study which asserted that teachers did consider the subject matter in their decision-making. What dominated teacher decision-making were considerations for (1) student development, (2) curriculum guide objectives, and (3) pressures of accountability. In information-processing terminology, Duschl and Wright elaborated:

> The argument is made that teachers' problem space is dominated by factors other than those associated with the nature and structure of the subject matter....[it] is defined as successfully contributing to student development, meeting curriculum guide objectives, and coping with pressures of accountability (p.27).

The results of this study suggested that teachers gave little to no consideration to the nature of the discipline from which the instructional tasks were taken. Institutional constraints, such as the "climate" (p. 28) of the school, heavily influenced teacher decision-making. What to teach and how to teach were decisions placed outside the domain of teachers. This disenfranchisement of autonomy was suggested as contributing to the

"deskilling of teachers and the erosion of the profession" (p. 29). Teacher decisions were based on consideration of the learners; they were not made on consideration of the nature of the subject matter being taught.

Other studies in science education related to decision-making in the classroom focused entirely on the students. Aikenhead (1989), for example, tested two competing sociological theories of group decision-making: the social decision scheme and the valance distribution model. In the context of Science-Technology-Society (STS) education, he cautioned future researchers that his quantitative analysis of data indicated decision-making models from sociology and psychology held little hope for understanding of student decision-making.

> Those decision-making models seem to hold little promise in predicting the more complex decisions associated with socioscientific issues. Researchers in STS education would be well advised not to pursue the predictive function of decision-making theories" (p.201).

**Case Study #1: Mrs Guide's Decision-making**

Mrs Guide was a 31-year-old, married White woman with no children. She had multiple degrees in education: B.A. (1983) and MEd (1988). During the time she participated in this study she completed all requirements for her Specialist Degree in Education, EdS (1992), offered at the state university.

Mrs Guide taught three sections of life science and one section of Language Arts at pseudonymous World Middle School (WMS) during the 1991-1992 school year. She had taught middle school science for five years at WMS.

Before-Teaching Decision-Making

Classroom Environment Decisions: Before Mrs Guide developed her plans for teaching life science to her students, she considered the classroom environment. This included the classroom decor, the arrangement of the students' desks, and the placement of her students.

Mrs Guide personally "hate[d] a bare classroom" (field notes, 3/6/92) and made an effort to make her science room visually stimulating for both herself and her students. Her classroom contained bookshelves with science books, science posters on the walls, science and sports mobiles hanging from the ceiling, and displays on safety in science and the scientific method on the collapsible wall she shared with the adjoining classroom.

Mrs Guide also gave attention to the physical arrangement of the students' desks. Since she steadfastly believed in cooperative learning groups, she arranged the 28 desks in her room into small groups of four to six desks. In each of the groups, desks faced the other desks to encourage student to student communication. The groups were scattered in a non-linear fashion throughout the room. Spaces between the groups of desks allowed for easy teacher movement around the classroom.

Mrs Guide assigned students new seats in her life science classrooms every six-weeks grading period. After the first grading period, on the first day of each new grading period, students would enter the class and find a new seating chart on the board. In the "Topography of the Culturally Diverse Science Classroom" activity (see Appendix C), Mrs Guide described her considerable efforts in deciding where to assign seats in her life science class:

> Researcher: How did you decide on this seating configuration?
>
> Mrs Guide: Starts with who is going to talk with who. You put them on opposite ends of the spectrum. It started out with consideration of who interacted with who. And part of it is if someone needed something special, I put someone strong with them. I also try to even it out boys and girls....[I] balance boys and girls because these are also cooperative groups. Exception being the group to the right. Two males were moved out, talkers. I do not change my seating chart in the middle of a grading period unless I absolutely have to. Then I look somewhat at ability. Do I have a kid that is weaker and

> should sit next to a kid who is willing to help? I think about that, but it is not always the main focus of where I put kids in the room. [She explains she did that for two White males in the 4th period life science class] I also think about eyesight (e.g. [Iranian female student sometimes does not have her glasses; I move her for that day]. Sometimes left handers. Please don't ask me if I have any left handers in 4th period! I do not know if any are left handed in this classroom (activity, 4/16/92).

Mrs Guide's seat assignment for students in her life science classroom was primarily driven by a consideration of the following student characteristics: talkers, gender, ability (including a disposition to assist others), and eyesight.

Mrs Guide also considered student differences when she grouped students. Although she did not think it necessary to consider the number of international and African American students in her classroom and then attempt to assign at least one to each small group, she assured herself that all of the culturally diverse students were not clumped in one area (field notes, 4/28/92). She did not want to teach "segregation"; she wanted to teach students "how to get along with different people," which was not determined solely by ethnicity, but was sometimes influenced by that (field notes, 4/28/92).

After the science classroom environment was arranged to her satisfaction, Mrs Guide concentrated on planning both individual lessons and entire units of her life science course.

Science Unit Planning Decisions: In planning her unit on Botany, Mrs Guide was observed to follow a seven step sequence.

**Step one** concerned the most appropriate time in the school year to teach a unit on Botany. In the year's planning, Mrs Guide looked over Independence County's Seventh Grade life science Objectives and decided that several referred to the life science topic Botany (See Appendix H). She decided that Botany should be taught in the spring when

plants were growing instead of the late fall or early winter (discussion, 5/4/92). A consequence of that decision was students would not proceed sequentially through their science textbook throughout the school year because the unit on plants appeared early in the textbook.

**Step two** was to review all past lesson plans and materials relating to Botany which Mrs Guide had used to teach Botany in previous years. Mrs Guide had collected all her past notes and lessons relating to Botany in a "Plant Notebook," a three hole binder. Activities and lessons were evaluated on how well "they had gone over with the kids" and selected for inclusion this year accordingly (field notes, 4/21/92). Mrs Guide preferred cooperative learning activities that had a hands-on component but was heavily influenced by anything that would keep students on task--anything visual or a sheet to fill in. She explained, "I've just learned over time that they [her students] need it [focusing through concrete objects] (field notes, 4/21/92).

**Step three** was to review Botany-related films and videos. Once again, films and videos were selected according to positive past experiences with students. Scheduling of the films and videos was constrained by the availability of the VCR.

**Step four** involved the student's science textbook to assure no substantive content was neglected.

**Step five** involved checking the Botany lesson plans against the school district's objectives for Botany, that the former conformed to the latter.

**Step six** was to schedule each day's lessons, including tests, for the time period available for this topic. The time available for teaching the Botany unit was limited by the

necessity of also including a unit on Ecology before the school year closed.

**Step seven** was to schedule student assessment experiences and to decide what type of assessment to give. During the study, for example, Mrs Guide decided to give her students a performance-based assessment (Pb-A) to identify different plants instead of a typical paper and pencil test.

Mrs Guide's student teacher offered her perspective on the decision-making process she observed Mrs Guide following when planning for a science unit:

> Researcher: From your perspective, what did you learn from Mrs Guide on how to teach a topic?
>
> Student teacher: She always likes to keep in mind the students need a lot of hands on and things that can be related to their life and what they are doing. The abstract concepts and the notes and just talking about the information, she is not partial to that. She likes to have the kids discover for themselves through labs, through activities that we do with them. It is kind of like a self-discovery process, I would say. The activities, she likes for them to be actively involved--to take on their own responsibility to find out their information. That is what I have observed about her.
>
> Researcher: What kind of decisions took place on which materials to use?
>
> Student teacher: Oh, the possibilities are endless. She is just a walking resource. Well she has so many textbooks. She is on the textbooks selection committee so not only do we have the school's textbooks but she has her own collection. Things that she has collected over the years--activity books, lots of resources. The school has a resource room you can get materials from. The libraries, the films, things like that. Things just come off the top of her head. She's like, 'Well, we could get this and dissect this....'
>
> Researcher: Does any particular example come to mind on a decision-making episode where you two considered options and one thing was chosen?
>
> Student teacher: Well, when we were talking about the parts of a flower, and considered all the different types of flowers to pick from to show the students, she said that the Day Lily showed all the parts we needed and those were fairly easy to dissect and that the kids would be able to see clearly the parts of the flower and be able to label the parts...(interview, 6/4/92).

From the student teacher's perspective, the primary determinant in Mrs Guide's planning was to pick hands-on activities and lessons that related to her students' everyday interests. Lecturing as a way of giving out content information was not stressed. Mrs Guide was "a walking resource" who could consider the different resources available "off the top of her head."

Individual Science Lesson Planning Decisions: Once more encompassing decisions were made about the science unit, decisions about individual lessons were made. Mrs Guide's first decision related to lesson plans. WMS's administration required her to turn in each Monday an outline of her week's life science lessons. Although she supported the requirement because it focused her attention on what should be taught she felt that very detailed lesson plans were unnecessary at that point in her career.

> Mrs Guide: I turn in lesson plans every Monday. I mean they never stop evaluating you that way. I do not think there will ever be a time when I do not have to do it. I hope I do not--it keeps you focused. When you have to write it down, make sure you are dealing with the level of kids that you have, you need to be conscious of what you are doing on a day to day basis (day observation, 5/14/92).

After the decision was made to have lesson plans, decisions were made by Mrs Guide while writing them. One strategy taken in this study to gain access to the decisions Mrs Guide made in her lesson planning, was to conduct a formal interview on April 21, 1992 with Mrs Guide immediately before she taught a life science lesson.

In general, from Mrs Guide's perspective, the decisions that she made planning an individual lesson were stated as the following:

> Mrs Guide: I take into consideration what Independence County says I need to teach. You know, the specifics they have that they want taught. Then I take

into consideration anything I think will be enrichment to those ideas and anything extra I have time for that I can put in that I think kids will either enjoy or need to know. Of course, some of it comes up after I have planned. Like, if there is a particular area that comes up that they do not understand or want more information on. You can't plan for everything. Basically, I have to follow what Independence County wants me to have them learn. So I try to devise the lessons to meet that. They do not tell me how to teach it--just what needs to be taught.

Researcher: How would you outline what decisions you make before teaching a science lesson?

Mrs Guide: In deciding how much time I am going to spend talking to them and how much time I am going to allow them to work in class--those are decisions I have made. Decisions on when their vocabulary is due, what words, vocabulary I want them to have, whether they can use a homework pass [pass to skip a certain homework assignment--2 for A students per marking period] (interview, 4/21/92).

The most powerful decision Mrs Guide made before teaching individual life science lessons was to select information from her knowledge base that she believed would enrich the lives of her students. The constraining elements in her lesson planning were the district objectives and time. From Mrs Guide's perspective, there could be no deletions of the district life science objectives; district life science objectives could only be augmented. Time was a constraint in two ways: both in how much content she could teach and in how much she could allocate to different components of her lesson.

The two instructional alternatives she perceived in the immediately upcoming life science lesson were lecture and independent student work. Decisions involving what vocabulary words to give her students, when the assignment would be due, and if students could use a pass not to do them also had to be made.

Mrs Guide took into consideration other information before making her pre-instruction pedagogical decisions. She considered the ability of her students to complete assignments

within a certain length of time; she considered their attitude toward an assignment (but would not let their dislike of a task necessarily stop her from giving it to them); and she considered language difficulties international students might have. Although she refused to consider gender and cultural differences represented in the room, she factored into her decisions moral values which conflicted with an activity, such as dissection in life science instruction.

In a discussion on April 28, 1992, Mrs Guide asserted that her decision-making concerning the amount of science content she taught in life science was influenced most by a belief she held:

> Mrs Guide: I teach information but so much more. The issue revolves around what do I teach? I teach both, but the emphasis is on the latter [socialization] because you can get along without information or content. For example, do I teach segregation (by allowing students to clump or bunch together), or do I teach we need to get along with different people (field notes, 4/28/92)?

During-Teaching Decision-Making

Scenario:

> Mrs Guide's students are in a jagged line and are being led by Mrs Guide and her student teacher down the hallway from the lunchroom back to Mrs Guide's science classroom. Mrs Guide turns and yells back toward an African American female student who is talking and laughing with an Iranian female student.
> Mrs Guide: (yelling) Tameka! Did you hear me say, "Stay quiet in the hallway?"
> Tameka: Sure enough I did!
> Mrs Guide: [No comment--just a facial expression suggesting "I'm not playing now" directed toward Tameka. Tameka stops talking.]
> Tameka goes into the bathroom.
> Student teacher to Mrs Guide: Tameka said, "She is good children" to me yesterday.
> Mrs Guide: She tries it [Black English] on me, but I do not respond. I say, Excuse me? [Mrs Guide's emphasis] When you respond correctly, I'll respond.
> Mrs Guide (to researcher): You know, that is a cultural decision I have made [to have Tameka

speak standard English and discourage her use of Black English in school]. (field notes, 3/31/92)

In this section, an analysis of Mrs Guide's decision-making during life science instruction with culturally diverse students is presented. Data used in the analysis were edited lesson portions of the videotaped life science lessons, transcriptions of Mrs Guide's reflections on those edits, and transcriptions of the researcher's comments on the edited portions.

During the study period, complete life science lessons taught by Mrs Guide were videotaped by the researcher. The lessons included classroom lessons and laboratory experiences. Mrs Guide's videotaped lessons were edited for Teacher Practice Critical Incidents (TPCI) and then presented to her for her reflections. Sixty-six classroom incidents involving non-mainstream students were on the videocassette which she privately watched while responding to a written structured protocol supplied by the researcher.

Before receiving her audio-recorded reflections on the TPCI, the researcher viewed her TPCI tape and made comments of each TPCI in these three areas:

A. Summary of classroom action
B. Pedagogical (and Pedagogical Content Knowledge)
C. Multicultural implications

After receiving Mrs Guide's audio-recorded reflections (approximately one hour in length), the researcher

transcribed her comments and included that data in the analysis of her decision-making.

Analysis of Mrs Guide's During-Teaching Decision-Making: Analytic induction and the constant comparison procedure (Glaser and Strauss, 1967) were used to analyze the instructional decision-making that Mrs Guide performed during her life science class.

The first step in analyzing the data for decision-making required separating out those TPCI's for which Mrs Guide provided no alternative teaching strategies. By definition in this study, decision-making required a judgment between pedagogical alternatives. If there were no alternative pedagogical alternatives identified by Mrs Guide, her action was termed ritual instructor-action practice, or in abbreviated fashion, ritual i-action practice. The researcher defines ritual i-action practice as teacher action taken during teaching that is characterized by being one-responsiveness. No other action in that instructional situation is considered by the teacher due to the teacher's idiosyncratic perception of cultural mores of pedagogical practice in her local culture. Ritual i-action practice is considered the opposite of Decision-Making instructor-practice or, in abbreviated fashion, D-M i-practice. D-M i-practice is characterized by teacher judgments between perceived alternative pedagogical techniques. Of the 66 TPCI reflected on by Mrs Guide, 40 were classified as ritual i-action practices.

A hint of the cultural teaching practice mores underlying Mrs Guide's life science instruction came from the rationale she provided for her ritual i-action practices. An interpretation of her rationales for the ritual i-action practices produced exploratory mores of teaching practice for Mrs Guide.

Of the remainder 26 TPCI documenting decision-making instructor-practices, six analytic categories emerged using analytic induction (Glaser & Strauss, 1967). The source of data was Mrs Guide's Reflections on her TPCI. The categories were binary: Oral or Visual, Provide the Answer or Make Students Find the Answer, Consider Student Questions or

Avoid Student Questions, Use Class time or Save Class time, Emphasize Content They Need to Get or Let Them Identify Content They Need to Get, and Make Allowances For Students' Ability Differences or Treat All Students the Same.

In Oral or Visual, Mrs Guide's during-teaching decision-making required a choice between whether she should present information to her students through an auditory technique (e.g. lecture or teacher statement) or through a visual technique (e.g. notes on board or on overhead transparency).

A TPCI which exemplified that D-M i-practice was the following:

> TPCI #1
> Summary of Classroom Action
> It is the beginning of life science class. The teacher is at the front of the room and the students are rustling about; one White male student walks behind the teacher.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher calls the class to order. She has reminded them that she has asked them to get out their notebooks, textbooks, and a pencil or pen. She states that if there is a problem with that, she will have to make it easier for them to understand.
> Teacher's Reflection on TPCI
> Take their materials out, orally. Did this because it is a practice we are doing all year long. At the beginning of the activity tell them at the beginning what it is actually they will need. I guess the alternatives would be I could have written it on the chalkboard or I could have had posted on an overhead (TPCI Reflections, 6/28/92).

In Provide the Answer or Make Students Find the Answer, Mrs Guide's during-teaching decision-making was between giving her students an answer or eliciting an answer. A TPCI which exemplified that D-M i-practice was the following:

> TPCI #35
> Summary of Classroom Action
> The teacher lectures by reading off of transparency and adding comments. She asks the class the difference between two terms. She listens to suggested answers and picks one student to take responsibility to look it up in the

textbook and report back to the class.
Pedagogical (and Pedagogical Content Knowledge)
The difference between xylem and phloem is discussed. The teacher asks the students to explain the difference. When a number of students disagree, she picks one student to look it up in the book to resolve disagreement.
Teacher Reflection On TPCI
There is a lot of discussion about which one is phloem and xylem. So opposed to me just giving them the answer, this is an important concept. One they should already know. And two, they are going to need to know. I appointed Leon [African American male] to find the answer and make it his responsibility to report back to the class after he finds it in his book. Because I want them to understand this is important and I will not just give it to them. I am afraid if I just give it to them....It is important that they got it (TPCI Reflections, 6/28/92).

In Consider Student Questions or Avoid Student Questions, Mrs Guide's during-teaching decision-making required a choice between focusing on student questions during the lesson or avoiding discussion of student questions. A TPCI which exemplified that D-M i-practice was the following:

TPCI #31
Summary of Classroom Action
The teacher stands in front of the room and answers student question. She invites students to contribute to answer.
Pedagogical (and Pedagogical Content Knowledge)
The teacher provides several reasons to why students should learn the scientific names for parts of organisms in Botany: to not pick poison ivy and get a rash, and it is "similar to the fact that we must all know a few bones and muscles of the body and other things in our body, it is important to know their structures--how they work and why they [plants] are such a benefit to us."
Teacher Reflection On TPCI
Here N [Nomusa] has a very important question: Why is it that we have to study this? I give a kind of funny answer to begin with but then in all seriousness answer her question. In actuality she was able to answer her own question through other questions that I asked and comments the other kids made. It made me feel good that they knew why it was there and why plants are here and why it is important. Other alternatives would have been to not answer her question or ask her to go look it up and explain. But this is one of

those teachable moments again. You don't want to throw kids off by one, ignoring them or by two, sending them to look it up. Most kids who have a question want it answered immediately. And because it was one I could answer and she could answer given a little guidance we worked our way through it and got an answer (TPCI Reflections, 6/28/92).

In Use Class time or Save Class time, Mrs Guide's during-teaching decision-making required a choice between using class time for an activity she perceived as valuable or saving class time by not pursuing an alternative strategy. A TPCI which exemplified that D-M i-practice was the following:

TPCI #40
Summary of Classroom Action
The teacher lectures in the front of the room using a transparency on an overhead projector. The transparency shows a diagram of a stem cross section. Students have a question about the drawing. One student [an African American male] stands up and goes to the screen and points out the structure he has referred to [an inverted triangle] that the teacher could not find in the diagram. The teacher continues lecturing, asking the class questions about the diagram.
Pedagogical (and Pedagogical Content Knowledge)
The teacher shows the cambium using a transparency. She allows a student [African American male] to leave his seat and point out which structures he believes illustrate the cambium on the screen. The teacher confirms that is the cambium (like an inverted triangle) and asks what on the outside of the plant. In response to a question concerning epidermis, she gives the everyday word 'bark.'
Teacher Reflection On TPCI
I am impressed they called it epidermis and not bark to begin with! Once again we are still using the overhead. I noticed you showed their packets [she gave them good drawings so they could spend more time labeling structures instead of drawing]. Alternative, to draw them. But there is a time frame as well--instead of wasting a lot of time with them drawing, go ahead and give it to them and then we go on moving through the material (TPCI Reflections, 6/28/92).

In Emphasize Content They Need to Get or Let Them Identify the Content They Need to Get, Mrs Guide made a choice during instruction between highlighting content that she thought was important and should be learned as opposed to placing the responsibility on her

students themselves to identify important content. A TPCI which exemplified that D-M i-practice was the following:

> TPCI #18
> Summary of Classroom Action
> The teacher chooses a Vietnamese female student to begin reading text from a silent filmstrip. She stops here after a short time to point out to the class that she has just answered a question asked on the handout.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher has chosen an audiovisual (filmstrip) that engages the students by having them read text from it. The filmstrip's content focus is plants. She has decided to point out to her students when information they need to complete an assignment is mentioned.
> Teacher Reflection On TPCI
> Since the filmstrip did not have an audiocassette with it I had students read the print at the bottom of the filmstrip. When we got to that particular segment, one of their particular questions was being answered so I have them stop and said, 'Question #2.' I even pointed them in the direction of what they were looking for. Because many times when they are watching a filmstrip and watching to answer questions, too, they sometimes miss information thinking about the question, or reading on to the next questions, or writing the answer to a question so I wanted to make sure they were focused on just what exactly which question was being answered at this particular place. An alternative would have been to just keep right on reading and not to have stopped for them (TPCI Reflections, 6/28/92).

In Make Allowances For Students' Ability Differences or Treat All Students the Same, Mrs Guide decided during instruction between acting in recognition of students' ability and language differences, and treating all students as having the same ability and language skills. A TPCI which exemplified that D-M i-practice was the following:

> TPCI #30
> Summary of Classroom Action
> The teacher walks to back of classroom, turns off video and sits on the lab table, swinging her legs, as she calls on students to share facts they gathered.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher agrees with a student that a good respiratory question would be air goes through the nose to the lungs. The teacher repeats all her students' responses.
> Teacher Reflection On TPCI

> Benefits of [this] strategy would be for kids who are slower learners or may have trouble with the "science language." They have an opportunity to make sure their facts are right or they took down the right ones (heard correctly). Can take down other facts if they did not get them all. I rarely check to see if they get all the facts [only check if they are off task]. I also repeat what the kid says so everyone in the class gets the opportunity to hear it. Also verifies that they have heard it correctly (TPCI Reflections, 6/28/92).

During-teaching decision-making TPCI With Multicultural Implications: To Mrs Guide her students were "all kids to her" and that gender, race, and ethnicity were not to be given emphasis [this belief was described as the analytical construct They Are Kids (In School)]. However, an analysis of the TPCI's indicated multicultural issues were involved in a few of Mrs Guide's during-instruction D-M i-practices. Mrs Guide considered the language skills of her students (an English as a Second Language issue), her gender and its affect on her instruction of life science (a gender issue), the different cultural lifestyles of her students (a cultural lifestyle issue), and the explicit identification of the different races represented in her classroom for use during a life science application example (overt acknowledgement of student differences issue).

English as A Second Language Issue: Mrs Guide's belief that life science was expressed in a scientific language [described as It Is Expressed In A Scientific Language] influenced her to emphasize scientific vocabulary in her life science classes. Since many of her students were internationally born and English was not their first language, Mrs Guide believed it necessary to take actions to facilitate their learning the scientific language of life science. D-M i-practices that she made were to repeat student answers and to emphasize the scientific words presented in audiovisuals. She also was sensitive to the delays ESOL

speakers had processing information in English. As a result, she believed it would be better in her teaching practice to remember to give those students ample opportunities to answer questions multiple times. Two TPCI which exemplified that D-M i-practice were the following:

> TPCI #30
> Summary of Classroom Action
> The teacher walks to back of classroom, turns off video and sits on lab table swinging legs as she calls on students to share facts they gathered.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher emphasizes a fact that would be a good respiratory question (air goes through the nose to the lungs). The teacher also repeats students' answers.
> Teacher Reflections of TPCI
> We discussed [the science vocabulary words] at the end of the video and asked for facts. Benefits of this strategy would be for kids who are slower learners or may have trouble with the "science language."[emphasis added] They have an opportunity to make sure their facts are right or they took down the right ones (heard correctly). Can take down other facts if they did not get them all. I rarely check to see if they get all the facts [only check if they are off task]. I also repeat what the kid says so everyone in the class gets the opportunity to hear it. Also verifies that they have heard it correctly (TPCI Reflections, 6/28/92)
> TPCI #39
> Summary of Classroom Action
> The teacher points to drawn examples of monocot and dicot stems on a transparency and asks the students to describe what differences they notice. She calls on a Chinese male student and then on two other students in succession [both White female] to respond to the same question. The teacher uses the transparency to illustrate differences in stems.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher asks the students to look at drawn examples of monocot and dicot stems and tell her the main difference between them. A nonvolunteer Chinese male student is called on who discusses monocot and dicot seeds. The teacher says what he said about seeds is good but the focus of the question is on stems, not seeds. She then calls on two White female student volunteers. The teacher states that the difference is that dicots form rings on the outside of the stem.
> Teacher Reflections on the TPCI
> Here I should have come back to Tung [Chinese male student]. I did not even notice I had not done that after he gave an incorrect answer and yet a correct

answer at the beginning. Here we are trying to find out the difference between two types of stems that are on an overhead. And we worked through it through overheads and stuff to get to that answer. Tung was on target knowing we are talking about a monocot and dicot stem--he knew the difference among the seeds. What I should have done is turn right back to him and said, 'Ok what is the difference between these two stems?' and see if he could do it. Looking at the video, it took him a few seconds to realize what he had done and then to think about what changes he had to make and then it appeared he did have an answer because he had his hand up. I wished I had seen that when I was teaching. But there again is one of the faults: you do not always get back to those you should get back to [emphasis added]

(TPCI, 6/28/92).

Gender As An Issue: Mrs Guide stated that the gender of her students did not influence her life science instruction. However, she did consider how her own gender influenced her instruction of a student laboratory on stomates. One procedure in the lab required her students to use fingernail polish to lightly cover leaves. She was surprised when many of her students (both male and female) did not know how to use fingernail polish. She assumed that since she had experience with fingernail polish as a female in this culture that her students would too. In subsequent instruction of the lab, she modeled how to apply a thin coat of fingernail polish on leaves for the students.

TPCI #45
Summary of Classroom Action
The teacher demonstrates how to apply fingernail polish to the leaves as indicated by the lab's directions. Students at their desks watch.
Pedagogical (and Pedagogical Content Knowledge)
The teacher indicates that an earlier class had difficulty with placing fingernail polish on their leaves. She demonstrates how it could be done effectively.
Teacher Reflection On TPCI
I had learned a valuable lesson in the first lab. That was students really do not know how to put a thin layer of fingernail polish on. I guess being female, I may have assumed, and unrightly so, that kids know how to do this [emphasis added]. So with the second class [this one] I actually gave an example of it on leaf and gave them instruction on this particular aspect of the lab. I learned from the first time I did it what I needed to fix for the second time. And as

we can tell from the lab, it went a whole lot better (TPCI Reflections, 6/28/92).

A Cultural Lifestyle Issue: An instructional belief Mrs Guide held was to make life science relevant to the students lives [this belief was described as I Make It Relevant]. Her strategy to do this was to use everyday examples to illustrate life science concepts. She was aware that her culturally diverse students lived different lives from the lives of her White students, so she could not assume they would relate to examples she might use with a typical middle class White American student population. As a result, a during-instruction D-M i-practice she demonstrated was to pick the classroom or school as a common referent point for her students since she was confident that was a common experience they all shared. A TPCI that exemplified that D-M i-practice follows:

> TPCI #58
> Summary of Classroom Action
> The teacher reads the notes from the transparency. She asks students a question. She repeats the answer.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher compares the class to a community in the ecosystem of the school. All the students make up the community.
> Teacher Reflection On TPCI
> Here again we are looking at another level in the ecology hierarchy. I have given them a definition and had them apply it to a situation. To start out with a forest and then went to the classroom or the school. The school was something everyone had a reference point with because we were all in school [emphasis added]. It would be hard to believe they had no reference point to the forest, but it is easier to start with the school and later move back to the forest (TPCI Reflections, 6/28/92).

Overt Acknowledgement of Student Differences Issue: Mrs Guide strongly held the belief that the differences her students had due to their cultural diversity was an obstacle to overcome in effectively teaching life science [this belief was described as Their Differences Are An Obstacle]. She tried to treat her students as if they were all the same so no one felt

differently in school [described as They Are All Kids to Me (In School)]. In one videotaped instance of during-instruction D-M i-practice, however, she chose to use the students' suggestion that the characteristic of "race" could be used to categorize her life science class into different populations. That action was consonant with her instructional belief that students should feel comfortable talking about themselves in her life science Class [described as We Talk Freely About Ourselves]. Mrs Guide later expressed in her TPCI reflection that while she recognized that students were adept at picking out the different ethnic groups in her classroom she was glad that they did not always see other as being different or from different cultural backgrounds.

> TPCI #61
> Summary of Classroom Action
> The teacher interactively lectures with the students participation.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher accepts the student suggestion of race as a characteristic for dividing the class into populations. She asks students what races are represented in the class. Students call out Blacks, Whites, Oriental. The teacher asks if there are any American Indians? She looks around and says no. A student suggests Middle Eastern. An African American female student nods her head yes. The teacher continues the exercise by taking gender (which she claims would be the easiest to start), then hair color. Each particular group is a population.
> Teacher Reflection On TPCI
> Here I have further gotten them to look at their populations, and if they chose race, which one would they chose. (And I am wondering if you chose this to see what they would pick out. They are very aware that there are different races in their room and they did a very good job giving them the correct labels for lack of a better term here. So yes, they are adept at it, but also they had to think about it a little bit. Like I have told you over and over again, I do not think that they always see other as being different or from different cultural backgrounds. I am glad they don't--that they have to think about it for a minute and decide.) As I watch I notice it took them longer to take them to come up with their categories for that particular population than it did for hair color per se (TPCI Reflections, 6/28/92).

After-Teacher Decision-Making

Mrs Guide's after-teaching decision-making focused on her evaluation of the lesson. Components she considered in her evaluation of the life science lesson were its match with her lesson plan, an identification of any unexpected decisions that needed to be made during instruction, and what she learned from the lesson.

Evaluation Of The Lesson

In reflecting back on a life science lesson she just had taught (4/21/92), Mrs Guide first evaluated her lesson on the basis of how closely it matched her lesson plan. She decided it had followed her plan, so the lesson was evaluated as effective lesson planning:

> Researcher: How did your pre-class planning play out in the science lesson?
>
> Mrs Guide: Pretty well, pretty well. I think it did what it was supposed to do. I mean the kids, they followed the plan I had. So I think it worked out fine....I had to monitor the time to make sure they knew how much time they had. Basically, things went just the way I had planned for them to go (interview, 4/21/92).

Mrs Guide's decision to make the focus of her life science lesson a vocabulary assignment was driven by her belief that students needed to know technical scientific terms to make the study of a topic like botany "science."

> Researcher: Is vocabulary a necessary ingredient of biology?
> Mrs Guide: I think at this level, yes. Because if I am going to teach it as science, then they need to understand the science of the words. If they are sitting in a biology classroom in high school or college, or anywhere, that is how the words are going to be addressed. They are not going to be watered down or in layman's terms. They are going to call them by their science names. Therefore, I think they should understand that those names are there for a reason. That their understanding of that vocabulary is imperative to the lesson. (interview, 4/21/92)

Overall, Mrs Guide evaluated her lesson in the following manner: "It basically was a pretty boring, yet necessary lesson (laughing). That is how I classify vocabulary." (interview, 4/21/92).

In reflecting back on her lesson, Mrs Guide identified a decision she had to make that she had not planned before the lesson and evaluated how her lesson was affected:

> Mrs Guide: I had to remember to close down the human body and make a few comments about that before starting the botany unit. But, that happened in the sequence it was supposed to happen. I had to remember to do it. I remembered it when I was standing up there and had to do it. I do not know what made me remember it! It just dawned on me that I needed to do it and did it. (interview, 4/21/92)

The timing of her decision to include an unanticipated final discussion of the human body into her life science lesson was the central criterion for Mrs Guide's evaluation of the unexpected decision. Because the sequence of her planned lesson was able to continue in the order she had envisioned it, the inclusion of a closure to the Human Body topic at the beginning of the lesson was no problem.

Mrs Guide reflected on what she learned from her lesson and how that would influence later lessons in the unit.

> Mrs Guide: [I learned] that kids, when you ask them about plants, they think about the complex vascular plants. They do not include the nonvascular or simpler plants. I came to that conclusion when they could only name vascular plants. Therefore, those were the ones they were the most familiar with and focused in on when I asked the question.
>
> Researcher: How will you use that knowledge in a future lesson?
>
> Mrs Guide: Probably to put more emphasis on the nonvascular and simple plants, so that will bring it more to their attention. That those organisms are actually plants, also. (interview, 4/21/92)

Another instance where Mrs Guide put effort into learning from her lesson was after

an alternative assessment task she designed for her life science students. It was a performance-based assessment on plants. When her students did not perform very well, she decided to investigate and interpret what happened:

> Mrs Guide: My student teacher and I talked about it [the performance-based assessment] and decided it wasn't because they [her students] did not have enough time with the materials. First of all, when the test results are that poor (very low), you have to ask yourself as a teacher, What did I do wrong? What did we not prepare them for? There wasn't anything. Everything matched. What you give in class should be the criterion for what is on the test. If it wasn't the way we presented it, and the test did match the presentation in class, what happened? Upon talking with the kids, we found out they did not take it seriously and did not think we would actually give them this type of test. They had not studied. So then we said, good--it is not our fault. There are times when it is. That was not the scenario this time. (day observation, 5/14/92)

After deciding the students had enough time with the materials, Mrs Guide's decision-making process was a step-by-step Socratic investigation of why the students did not do well. The first questions she asked herself were "What did I do wrongly?" and "What did we not prepare them for?" After deciding that she did not do anything wrong, and that the test matched what was given in class, Mrs's Guide's next question was "What happened?" She ultimately decided that it was her students' fault because she perceived they did not take it seriously and had not studied. She decided to give a make-up test that was offered after school for those interested. Only a small minority of her students decided to do that.

> Mrs Guide: Fine, there will be a make-up test. You will have a second opportunity to do this same type of test. It will be given after school. Those who chose to do it a second time did much better.
>
> Researcher: What percentage chose to redo it?

Mrs Guide: Very few. I would say less than 10%. No, more like 20% of those who failed it came back to take it again?

Researcher: How do you explain that?

Mrs Guide: I can't. They just decided not to take an opportunity that was given to them to change their score. Was it because it is the end of the year--a lot of it? Or their true belief that one test does not make much difference in their overall grade point average.

Researcher: How about the factor the test was on their own time?

Mrs Guide: Yeah. I am sure some did not want to give up baseball practice or riding their bike or an hour of television. Some have transportation problems. But can't a parent bring you early or pick you up later? We had several who did (day observation, 5/14/92).

Even after this experience with an alternative assessment on plants, Mrs Guide decided that since she perceived that the problem lay with her students study habits and not Researcher: How does this experience with performance assessment (Pb-A) affect your pedagogy later?

Mrs Guide: It is still a viable form of assessment. It is an application--not a memorization exercise...(day observation, 5/14/92).

**Case #2: Mr Green' Decision-making**

Mr Green was a 23-year-old, single White male. In 1990, he earned a B.S. in biology from a state's university. In 1991, he participated in an alternative secondary science teachers certification program and earned teacher certification in science for grades 7 to 12. He also earned middle school certification for grades 4 to 8 by attending summer classes. During the time he participated in this study, Mr Green attended two evening classes a week at a state university. He was working toward his M.Ed.

Mr Green taught four sections of eighth grade earth science and one section of Interdisciplinary Studies at World Middle School (WMS) during the 1991-1992 school year. That was his first year of teaching.

Before-Teaching Decision-making

Classroom Environment Decisions: Before Mr Green developed his plans to teach earth science, he considered the classroom environment. This included the classroom decor, the arrangement of tables in his classroom, and the placement of his students.

Mr Green decorated his earth science room before the school year commenced, and by his students as the school year progressed. There were posters--science safety procedures, views of planets from space, Mr Green's name in another language, listing of the steps of the scientific method--school sport banners, a bulletin board that contained Science in the News articles or a map of the USA (depending on the lesson), a stand up folding map collection, drawings of the components of the solar system hung from strings near the ceiling, a shelf of student made models, and a list of daily assignments with objectives.

Mr Green's room did not have individual student desks. Instead, there were tables each of which seated three students. Mr Green arranged them so that the two rows of tables to the far right and far left faced toward the front of the room while the center row of tables extended lengthwise toward the back of the room. This arrangement facilitated the teacher's ability to walk easily from the front of the room to his desk or to the classroom door. This arrangement also separated many of the students into smaller groups, and provided space for Mr Green to maneuver between tables to talk with individual students.

Mr Green assigned students to their seats, and moved them depending on how he evaluated their off-task behavior in class. In the "Topography of the Culturally Diverse Science Classroom" activity (see Appendix C), Mr Green described how he assigned students seats in his earth science class:

Researcher: Why this configuration?

Mr Green: Yeah, I put them in this configuration. Some of the people are away from people they would talk to, others away from people they probably would talk to. For the most part I have let this class sit in the configuration [that] they probably would have chosen anyway (they have proven they could handle it). They have been in this configuration since right before the change of marking periods. [The two African American female students]--I like to keep them together even though they talk because Michelle kind of drags Tina along. Front three girls. They like to sit together and they do not cause a problem so I do not mind. Three girls in middle of right row, These three girls, same thing. Then three ESOL students--They can be very talkative but again they work together so I allow them to sit together because they get more done.

Researcher: Why [the girls of color] in the back left row?

Mr Green: No real reason. I keep [the Half Korean American female] in the front so I can keep her on task, keep an eye on her. [The white male in the back right row] I like to keep him separated from everybody (activity, 5/15/92).

Researcher: Any separations due to talking?

Mr Green: (Circles three females in left row). At first these three girls were separated all around the room. I have allowed them to go ahead and sit together (as I also have the front three girls, and the three ESOL students) (activity, 5/15/92).

Mr Green's seat assignment for students was primarily driven by twin considerations: keeping the students on-task and allowing them the freedom to sit with whom they wished. Those whom he evaluated as talkers were moved to the front of the room or isolated in the back. He also separated talkers around the room, but he allowed them to migrate back toward each other over time if they showed that they could stay on-task during lessons.

After the science classroom environment was arranged to his satisfaction, Mr Green concentrated on preparing to teach earth science content. He then focused on planning an entire science unit or a specific lesson.

Science Unit Planning Decisions: Mr Green met with the other two 8th grade earth science teachers at WMS and went over the county's curriculum at the beginning of the school year. Mr Green described what they did in that meeting:

> Mr Green: At the beginning of the year we 8th grade science teachers sat down and looked over how the county's curriculum matched up with the textbook. I could see how certain topics, such as the phases of the moon, would not be wise in the winter, or hydrology in January when you will not want to talk about water when you are cooped up in a classroom. Hydrology is good in the spring and weather is good at this time of the year [early spring] while the curriculum has it next to summer. Now [early spring] there is a lot of things going on in the weather. Those without science backgrounds have no idea about these things (discussion, 5/4/92).

Mr Green's unit planning was influenced by his concern with matching earth science topics with times of the year he felt would better fit the topics listed in the county's earth science curriculum. Another factor that influenced Mr Green's unit planning included his perception of his students' motivation toward certain topics.

Individual Science Lesson Planning Decisions: Mr Green was required by WMS during most of the year to prepare weekly lesson plans and show them to his supervisor. As a first year teacher, Mr Green indicated that much of what he wrote down in the plans were the objectives and ideas that the curriculum guide suggested.

> Researcher: You decided today that you would teach hydrology by emphasizing the physical and chemical properties. Why? Is this part of their curriculum?
>
> Mr Green: That is the first hydrology objective (day observation, 5/15/92).
>
> Researcher: Why did you pick today's lab?
>
> Mr Green: It looked like a good one. I found it in the earth science guide. Kids like to do things (field notes, 4/14/92)!

Mr Green decided mid-way through the school year to write down the daily objective

from the county guide on the green board for his students to copy into their notebooks. He thought that would add the needed structure his students needed to get started and to anticipate what they would be doing.

> Researcher: Could you explain your use of the objective on the board? Is that a school or an 8th grade thing?
>
> Mr Green: I haven't always done that. It is something I thought I would try this six weeks to see if I would like it and stick with it. We have been told over and over again, and I think, I have seen that it does change things if a kid knows without a doubt the direction we are heading in this particular class period, they do have more direction than if I should just stand up there and go. I do that too sometimes but I decided that one thing I would do to add to their notebook would be for them to write down their objective for the day....I have noticed that I have an easier time keeping them directed if at the beginning of class I make them copy and it is a good calming down kind of thing, too....It could act like a sponge (but it has purpose). It could act like an advance organizer. Only this acts as a direction (discussion, 5/4/92).

After deciding to use the county's objectives in the order he and the other earth science teachers had placed them, Mr Green made individual decisions on how to teach the objectives. He preferred to use hands-on cooperative learning activities instead of lectures. He decided to let his students group themselves in the small learning groups because he did not want to risk creating a feeling of resentment in his classroom. He used activities with which he was familiar and designed others around resource materials he found at WMS. He also used the Foxfire method for the astronomy topic which placed the responsibility of fulfilling the objectives on small student teaching teams.

> Researcher: Why did you chose this type of laboratory experience [students determined dew point using boiling water, mirrors, ice, and thermometer]?
>
> Mr Green: I don't know. I prefer hands-on unless I really need to get through something (field notes, 5/1/92).

Researcher: What guided your decision to teach with the weather boards today?

Mr Green: I decided on Friday after one of the other science teachers found them and said, Oh look what I found. And I said, I thought about it, and asked, "Are you going to use it on Monday?" And she said no, and I said, "Well I guess I will take them." And if she had, I would have said, well, I will take half (there are 30 of them) (discussion, 5/4/92).

Researcher: How do you decide to group students [for the cooperative learning experiences]?

Mr Green: I look at them as just kids. I don't care what they do. I do not separate them. There is no need for me to do it--they work. The more freedom I give them the better they work. They would resent it if I did that. I am most concerned with teaching science. It can create more of a problem if I try to mix them (field notes, 5/1/92).

There were times when Mr Green added to the county objectives. In particular, he valued environmental experiences, such as those associated with Earth Day. Mr Green justified adding those objectives because he felt they were good science objectives. Mr Green was co-sponsor of the school's Club Wild and stated that he taught earth science with an ecological focus throughout the year.

Mr Green: I've decided to take class time to teach Earth Day stuff. It is a lot more important than a lot of things we are doing. I will try to tie it in with my objectives....I've taught earth science with an ecological bias all year, so the students are used to the earth science environmental connection (field notes, 4/21/92).

Mr Green decided to be very flexible in how he taught his earth science lessons to his four classes. He tried different pedagogical strategies and allowed more time on certain components of his lessons depending on the interest of each class.

Researcher: Did you change the lesson today with each class?

Mr Green: Yeah.... I am very different with each class....that lesson, what I

> wrote on the board, changed with every class. If that is the direction you want to take it, then that is the direction we will take it. So in some classes, we would jump right to the heart (getting them to see the relationship between temperature and water vapor in the air). [His slowest class], I guess it was just luck of the draw, they jumped right to it and said, well, air holds more water when it is hot than when it is cold. So, I got to step right through the front door in that class, but in the other class I sort of had to tip toe through the back door. You know, try to steer them with questions, and what you put on the board (discussion, 5/4/92).

Other decisions Mr Green made before instruction were the commitment to enforce student use of safety goggles during laboratory experiences, especially if acid were used, and the investment of class time in going over tests item by item.

> Researcher: How have you decided to enforce the goggle rule?
>
> Mr Green: I go to them and tell them to put them on. It depends on how dangerous it is. Alcohol burners are not as dangerous as acid (field notes, 5/1/92).
>
> Researcher: Why go over the test item by item?
>
> Mr Green: Just to see if there are any questions on the items. Any missed credit....If I finish in time, I would like to start on hydrology (day observation, 5/15/92).

<u>During-Teaching Decision-Making</u>

In this section, an analysis of Mr Green's decision-making during earth science instruction with culturally diverse students is presented. Data used in the analysis were edited lesson portions of the videotaped earth science lessons, transcriptions of Mr Green's reflections on those edits, and transcriptions of the researcher's comments on the edited portions. During the study period, classroom and laboratory lessons taught by Mr Green were videotaped.

Analytic induction and the constant comparison procedure (Glaser & Strauss, 1967) were employed to analyze the instructional decision-making employed by Mr Green during his earth science class. The process was performed in the same manner as that described in the analysis of Mrs Guide's during-teaching decision-making. Of the 49 TPCI reflected on by Mr Green, 21 were classified as ritual i-action practices.

A hint of the cultural teaching practice mores underlying Mr Green's earth science instruction came from the rationale he provided for his ritual i-action practices. An interpretation of his rationales for the ritual i-action practices produced exploratory mores of teaching practice for Mr Green.

Of the remainder 28 TPCI documenting decision-making instructor-practices, three major analytic categories emerged using data from Mr Green's reflections on his TPCI. The categories were binary: Jump Straight Into It or Advance Organize It, Teacher Centered or Student Centered, and Ride That Wave or Nip It in the Bud.

In Jump Straight Into It or Advance Organize It, Mr Green's first decision-making instructor-practice involved a choice between openning a class session by "jumping straight" to the science content he planned to teach or to start his lessons by placing his daily objective on the greenboard and requiring his students to copy it into their notebooks as a type of advance organizer. He read the daily objective to them and explained what it meant or asked a student to explain what it meant. Mr Green began the school year by jumping straight into his earth science lessons. He became dissatisfied with that strategy as he noticed the amount of time it took to focus his students every day on the lesson and get started. He decided to

try the daily objective strategy his school principal advocated and was satisfied with it. "Eventually it becomes second nature." (TPCI, 6/28/92) Therefore, in almost every lesson observed for this study, Mr Green made the decision to use the daily objective teaching strategy with his culturally diverse students.

In a discussion, Mr Green explained his use of the decision to use a daily objective:

> Researcher: Could you explain your use of the objective on the board? Is that a school or an 8th grade thing?
>
> Mr Green: I haven't always done that. It is something I thought I would try this six weeks to see if I would like it and stick with it. We have been told over and over again, and I think, I have seen that it does change things if a kid knows without a doubt the direction we are heading in this particular class period, they do have more direction than if I should just stand up there and go. I do that too sometimes but I decided that one thing I would do to add to their notebook would be for them to write down their objective for the day....I have noticed that I have an easier time keeping them directed if at the beginning of class I make them copy and it is a good calming down kind of thing, too....It could act like a sponge (but it has purpose in this case). It could act like an advance organizer. Only this acts as a direction (discussion, 5/4/92).

A TPCI which exemplified that D-M i-practice was the following:

> TPCI #7
> Summary of Classroom Action
> It is the beginning of class. Students are sitting at their desks talking with each other. Mr Green walks to the back of the room, takes a chair off the top of a table and walks back to the front of the room. The screen for the overhead projector is pulled down, covering the greenboard in the front of the room. Mr Green walks back to the front of the room, says, "Ladies and gentleman, this is what you need to do. Today's objective. (He dramatically raises the screen to reveal the day's objective written on the greenboard--'Describe the major cloud formations'). Write it down. It will be the next page in your notebooks."
> Pedagogical (and Pedagogical Content Knowledge)
> Mr Green used a structured beginning strategy (students copying of the daily objective) to get his students focused on the learning objective he had taken from the county's curriculum. His use of the overhead screen added a dramatic touch the lesson and effectively got his students attention.
> Teacher's Reflection on TPCI

> I had just revealed the objective of the day. I like to give my class the objective so they have the direction and know where it is they are going, what they are going to be doing during that day. It is a visual cue. I also will have read the objective so they will get a visual cue as well as an audio cue and that gives them direction. Sort of an Ausebelian advance organizer so they know where they will be going to during this class period. I also have them write it down, so they not only see it, hear it, but they also act on it and write it down in their notebooks. This will be the next page in their notebooks. Alternative strategy: I didn't have to write down an objective. However, if one is being [evaluated] that is one of the things they look for to see if you have written the objective on the board, although they do not take anything off for it if you don't. But, I didn't have to write down the objective on the board. I could have simply jumped right in to the lesson and not given them any kind of organizer...It acts one as a sponge activity. It gets them right into what we are doing. And two, it gives a little more structure to the class. I have never been one to like too much structure, but give it just enough structure so it doesn't get wild (TPCI Reflections, 7/12/92).

In Teacher Centered or Student Centered, Mr Green's fundamental during-teaching decision-making was between whether he would make his lesson teacher centered (i.e. lecture, direct students to read from their textbooks, or instruct students to fill in worksheets) or student centered (i.e. use cooperative student learning groups in an activity, have students discuss topic in whole class question-answer technique, or have students make presentations to the class). Mr Green's preference was to keep his class student centered. He found lectures boring, and he thought students learned best when they were actively engaged in the lesson by doing something. Mr Green observed that students became bored with any one pattern of instruction, including student centered instructional techniques, so he occasionally lectured using the overhead for a change of pace.

Mr Green elaborated at the end of his reflections on his TPCI by referring to his decision to use student centered techniques during instruction:

> Mr Green: In looking over the TPCI, overall I was successful in making a mix between keeping control and keeping a pretty student centered classroom.

Science can be really student centered, if you want it to be. It lends itself to that so easily. Letting the students do the kind of things that need to be done instead of telling them how, or telling them what they are to know. Watching this videotape has helped me see there are places I can change. Perhaps make it even more student centered. I can make it more student centered if I can find more, or create more activities to do. I see that it works pretty well, what I do (TPCI Reflections, 7/12/92).

A TPCI which exemplified that D-M i-practice was the following:

> TPCI #8
> Summary of Classroom Action
> Students have copied the daily objective (Describe the major cloud formations). Mr Green stands in front of the room and tells the students what he expects them to do in the lesson.
> Pedagogical (and Pedagogical Content Knowledge)
> Mr Green states that students are going to explain to him, "who will pretend to know nothing," the three major cloud formations. Students will construct models of the cloud formations in cooperative learning groups and chose a member to present the model to the class and explain to Mr Green what they represent.
> Teacher's Reflection on TPCI
> I was giving them the task....I charged them with the task they were to do. The best way for someone to have to learn something is to have to explain it to someone else. The task I had given them was to build a model of the three major cloud formations, three major cloud types, and then be able to explain those cloud types to me. As far as alternatives, I could have stood and lectured to them about the cloud types but that probably would have gone in one ear and out the other and been twice as boring for me as it would have been for them. Therefore, once again, better for them to construct their own image for the cloud formations, and then perhaps explain that to me. They get a double dose of it and they have used a little bit of cooperative learning. Obviously that is what science is all about. No science works in a vacuum. So they have got that as well as to find out what the major cloud types are, to transcribe a two-dimensional picture or a written description in the book in a three-dimensional or quasi three-dimensional representation of those particular cloud formations onto a sheet of paper or any way they think they should. I put no limits, no boundaries, no parameters on their model building other than they had to use the cotton balls and the sheet of paper. Anything else was up to them....I group [three White males, one Chinese male] build three-

dimensional models of the cloud formations and used the paper rolled up on a pedestal. I put those three models on my desk and left them there for quite some time....being creative is important for science (TPCI Reflections, 7/12/92).

In Ride That Wave or Nip It in the Bud, Mr Green's during-teaching decision-making was between whether to rigidly stick with his lesson plan or to pursue questions his students brought up during instruction. Mr Green labeled the incidents when he diverged from his lesson plans to take advantage of his students' interest "teachable moments." Mr Green valued those times and thought that the best type of science instruction was in "riding the wave" of student interest instead of ignoring the students' interest and, therefore, discouraging that interest by "nipping it in the bud."

A TPCI which exemplified that D-M i-practice was the following:

TPCI #29
Summary of Classroom Action
Mr Green is writing notes on the board. A White female student asks him if she can ask him a question. Mr Green turns around and says, 'Sure, go ahead.' The student asks her question and the teacher repeats it for the class. He challenges his class to suggest ways to answer the White female student's question. He evaluates suggested student answers.
Pedagogical (and Pedagogical Content Knowledge)
Mr Green is pursuing a 'teachable moment.' A White female student asks if there is any way to make a cloud in a lab. Mr Green repeats her question to his class and decides to devote more than ten minutes investigating her interest. He gets his class to suggest ways they think they can develop a class lab to create a lab (listing their ideas on the greenboard) and critiques their suggestions.
Teacher's Reflection on TPCI
In this segment you see me diverging a bit. A student asked me how to make a cloud in class. What I chose to do which at the time was rather impromptu was to press that on. We have a problem: how do we create a cloud in class? Let's allow the class to brainstorm to see if we can get some answers. Design an experiment. This is a very important thing--hypothesizing about what might occur when you manipulate matter one way or the other to get certain results. It is a very important concept in science. There was no particular hurry to get on with what I had planned to do that day, so I decided to go

> ahead and ride that wave as far as the cloud would allow me to do it. I suppose I could have just nipped it right in the bud and said, 'You could create a cloud in lab by doing, whatever' and just told them that instead of letting them try to come up with ways to exercise their own imagination and creativity. I, however, allowed them to exercise some creativity as well as the ability to design an appropriate experiment and hypothesize what might occur in doing certain things. One student did suggest using dry ice, so that allowed me the opportunity to clear up his conception of what a cloud was and let him know our clouds are water droplets and not accretions of carbon dioxide. So this allowed several different things. And like I said it allowed us to go a little further. That is kind of one of the nice things about a class of gifted kids. They do like to ask different questions. Not that you have to be gifted to be curious because some of the other classes did similar things and I would take it as far as they could take it...(TPCI Reflections, 7/12/92).

During-Teaching Decision-Making TPCI With Multicultural Implications: Mr Green held the belief that his culturally diverse students were all kids to him and he was most concerned with finding common ground for them to work together instead of emphasizing their differences [this is described as They Are All Kids To Me (But The Black Kids Do Distinguish Themselves) and Adults Can Learn From Them]. He stated the only multicultural issue he found relevant to his teaching situation was a consideration of the religious beliefs his culturally diverse students held. However, an analysis of Mr Green's TPCI's indicated one other multicultural issue was involved in a few of his during-instruction D-M i-practices. Mr Green considered the language abilities of his students (**an English as a second language issue**).

**English as a second language issue**: In Mr Green's 2nd period earth science class, his three male ESOL students and one other male international student sat together in the back of the center row. Mr Green made modifications in his testing procedures for his ESOL students during written assessment tasks in class. Because they did not know English

very well, he decided to allow them to use their textbook during the assessment tasks. A TPCI that exemplified that was the following:

> TPCI #2
> Summary of Classroom Action
> The teacher gives students a quiz on an overhead transparency (there are five questions and one bonus). He tells them when he will pick up their responses and walks to the back of the room to where his ESOL students sat. He bends over and talks with two of them.
> Pedagogical (and Pedagogical Content Knowledge)
> The teacher is assessing his students individually by using a written quiz on an overhead transparency. He talks privately with his ESOL students.
> Teacher Reflections of TPCI
> At the end of this particular incident I was speaking with two international students, one from El Salvador, the other from China, Taiwan rather, telling them that they should try as best as they could on the quiz. Both of them can read pretty well English, even though they do not like to let on they can do that. Most likely I was going to let them use their book, although just from this videotape I am not sure, but usually that was the procedure I allowed them to use their book. The international students, that is (TPCI Reflections, 7/12/92).

Mr Green's ESOL students worked together in cooperative learning group activities. In one instance Mr Green expressed concern with their working together in a one group, but many more times Mr Green expressed satisfaction with their grouping.

> Researcher: How do you decide who works in student learning groups?
>
> Mr Green: I let them chose their own group members. I have a little concern with the ESOL group, however. They work together well, however. Juan translates into Spanish for Julio.
>
> Researcher: Why the concern with that group?
>
> Mr Green: Juan is not a leader. The group needs someone who will lead it. Otherwise, it is the "Blind leading the blind." (field notes, 4/14/92)
>
> Researcher: How do you decide to group students?
>
> Mr Green: I look at them as just kids. I don't care what they do. I do not separate them. There is no need for me to do it--they work. The more

freedom I give them, the better they work. They would resent it if I did that. I am more concerned with teaching science. It can create more of a problem if I try to mix them. (field notes, 5/1/92)

Mr Green allowed students to chose their own cooperative learning groups. His male ESOL students chose to work together, which by itself did not concern Mr Green, since he believed that the cooperative learning manipulative activities could be done by the ESOL students. He was not concerned that his ESOL students did not mix with the other students in his earth science class during cooperative learning experiences. What disturbed him was his perception that the group did not have a leader to lead the other students. Mr Green acted on this belief in his D-M i-practices by choosing to monitor closely the ESOL group's progress during cooperative activities. He spent time with them, explained laboratory procedures, and resolved misunderstandings. Two TPCI's which exemplified those D-M i-practices were the following:

TPCI #10
Summary of Classroom Action
The teacher is in front of the room writing on the greenboard as his students are working in cooperative groups. A male Romanian student holding his textbook leaves his group and goes to the teacher in front of the room. The student asks the teacher a question about what clouds in the book were the ones the teacher wanted his group to put in their model. The teacher shows him and he returns to his group and shows his team members.
Pedagogical (and Pedagogical Content Knowledge)
The teacher is using cooperative learning groups. Students are creating models of the three major cloud groups using cotton and paper. He allowed his students to pick their team members.
Teacher Reflections of TPCI
We see me clearing up what could of been a misunderstanding. The assignment was to distinguish between the three major cloud types. In the book there are pictures that illustrate the cloud types along with all the cloud types that are in between that are combinations and modifications to those cloud types. [A Romanian male student] was confused over which one I wanted them to build so I helped him to see that the ones I wanted him to build were the three main ones without the strato-, or nimbus-, or any of the

other prefixes or suffixes to make the modifications of the three main types. The particular strategy is the beginning of cooperative learning. I explained in the review of #9 about cooperative learning [There were not modifications for the international students in this particular case. The international students in this class, even though some of them do have some English problems, understood enough what it was I expected them to do. And since we were working with a manipulative in this particular case, there was no need to modify. They work well with their hands, and therefore, they should have no problems in the activity] (TPCI Reflections, 7/12/92).

TPCI #25
Summary of Classroom Action
Students are working on a laboratory activity in cooperative groups. A Romanian male student raises his hand and the teacher comes to his group. The teacher squats and talks with the ESOL students in the group.
Pedagogical (and Pedagogical Content Knowledge)
The teacher is using a hands-on laboratory to model the water cycle. Students use alcohol burners to heat water in beakers that have mirrors with ice on them above the evaporating water. The students' task is to explain how the laboratory set-up models the water cycle. The teacher works with the ESOL group that has asked him to help them.
Teacher Reflections of TPCI
I am working with the small groups rather than working with the class as a whole. Answering questions of the group of international students. Working in a set-up like this I am having more of an opportunity to work personally on a more individual type basis with the international students. They do obviously need a little more assistance than the other students which is giving me a good chance to do that. Most of the other students are able to go in a proper, go in a way by themselves (TPCI Reflections, 7/12/92).

After-Teaching Decision-making

Mr Green focused on evaluating the lesson in his after-teaching decision-making. Mr Green was in his first year of teaching earth science (although he did have experience teaching earth science during the student teaching component of his teacher preparation program). He expressed that his primary concern after instruction was in deciding how to

change the lesson to improve his performance the next time he taught the objective. He was concerned with how he could have made class presentations proceed more smoothly, with generating greater student interest, and with increasing physical safety in the laboratory.

Evaluation Of Lesson

Mr Green evaluated his lessons by many criteria. His primary criterion was how students reacted to his lesson. Mr Green was concerned with his students' interest in earth science and wanted them to find it interesting and useful in their everyday lives. He considered the time of day the students attended the class. For example, Mr Green thought it was harder to maintain student's interest during lessons after lunch.

> Researcher: How do you evaluate the discussion [during an earth science class he taught that day]?
> Mr Green: It went all right. For an after lunch class, it was all right (day observation, 5/15/92).

Mr Green decided to lecture as infrequently as possible to keep them (and him) from getting "bored" (TPCI, 6/28/92). When students mentioned boredom, he attempted to solicit suggestions for making a lesson more interesting.

> Mr Green: An African American student told me in 1st period earth science it was boring.
> Researcher: What did you decide to do about that?
> Mr Green: I asked him how then could it be changed to be more interesting to him. He had no answer (field notes, 5/15/92).

Mr Green was an advocate of students' hands-on laboratory experiences to maintain his students' interest in earth science. He realized the safety responsibility that accompanied that decision and took actions to reduce the possibility of student injuries. He emphasized safety by hanging a safety poster in his classroom and by modelling wearing goggles when

they were appropriate. Even with his high care for safety, in one laboratory experience, a student caused some acid to be sprayed when he added too much acid to a carbonate contained in a flask and the rubber stopper popped off. Mr Green handled the situation quickly and professionally by surveying the area, by rinsing the student's hand and clothes with running water, and by cleaning up the area with a base. Later, Mr Green evaluated the lesson in this manner:

> Mr Green to Researcher: How could I have made things go smoother?
> Researcher: Did you not think it went well?
> Mr Green: It could have gone smoother without the acid accident (field notes, 4/2/92)!

> Mr Green: [after reviewing videotape selections from the lesson] In this particular lab, there was a mishap. I remember a student happened to put too much HCL on the calcium carbonate pieces too quickly on a closed Erlenmeyer Flask. Well obviously, when you have too much gas being released, more than could fit through the tube into the collecting chamber, it forced the rubber stopper out...[there was a pop] and it caught students' attention quickly. It led to a teachable moment--scientists do make mistakes in lab. So many things are discovered serendipitiously. It added a little discussion of lab safety as well as gave me the opportunity to see that in the future when that lab is done to make sure that I admonish students not to put too much HCL in too quickly [emphasis added]. There is the possibility of an injury. Thank God no one was injured in that particular case (TPCI, 7/12/92).

During the study, Mr Green took graduate education courses two days a week in the evening while teaching earth science. For one of his graduate class projects, he decided to create a very thorough meteorology test for his students that utilized the skills he was learning in "Test and Measurements." Some of his students found it to be an out-of-the-ordinary assessment and made critical comments about it both in class and in audio recorded interviews with me. Later, I asked Mr Green how he evaluated the test:

Researcher: I heard your students make these remarks in class about your test: "This test was unreal!" and "You don't give tests that often, but when you do, this is a high school test." How do you evaluate that test?

Mr Green: I liked that test. There was a lot of preliminary stuff I went through. I probably never will do it again. But the actual construction of the test is OK. Like one student said, "I like this one better than the other tests because the other test were all essay." I'll show you that 30% of the test was knowledge, but the other 30% was analysis....I could probably do on it on a smaller scale (interview, 5/15/92).

Mr Green decided the test construction process was valuable but that time constraints would keep him from doing it again. He had the test items in his computer data base and planned on reviewing them for use when he tested students again on that topic next year.

Finally, Mr Green made decisions about how to evaluate lessons in which he took chances and for which he had no role model. For example, for the final exam in 8th grade earth science, Mr Green had persuaded the other two eighth- grade science teachers to allow students from across the three eighth-grade teams to work in small groups on a performance-based assessment. After one lesson observation, in which students worked in groups and Mr Green facilitated when requested by his students, I asked him how he evaluated the class:

Researcher: How did today's class go (students working on group final performance-based project)?

Mr Green: I was flying by the seat of my pants but things went OK. It was OK (even though I only received sheets from three groups) because the students were all focussing in on their projects (field notes, 5/29/92).

Mr Green evaluated the lesson positively because he perceived that the students worked together to learn earth science.

## Conclusions and Discussion

The guiding research question in this study was:

**1. How are pedagogical decisions of science teachers influenced by the students' cultural and ethnic backgrounds?**

Summary: Findings indicate that only in a few, discrete instances were the two participant science teachers' pedagogical decisions influenced by the students' cultural and ethnic backgrounds. Mrs Guide's pedagogical decisions that were influenced by her student's cultural diversity were to repeat individual student answers she thought important for the whole class (so that all students, including those students whose first language was not English, would have an opportunity to hear and learn from the answers), to give students who were still learning English repeated opportunities to answer questions (so that they could work through communication problems and be able to display the life science knowledge they possessed), to select the class or school as a referent for life science application examples (so that all the students would have a common referent point, even those students who led very different lifestyles due to their cultural and ethnic backgrounds), and once to allow her students to use their ethnic differences in an application problem in ecology in life science (so that they could apply their differences productively in a science problem).

Mr Green's one pedagogical decision that was influenced by his student's cultural diversity was to allow his English-for-speakers-of-other-languages (ESOL) students to sit together and work together in a cooperative learning group (so that he could better monitor them and provide assistance during small group learning activities).

The paucity of instances observed in which the cultural and ethnic differences of the

students influenced the teachers' pedagogical decision-making was congruent with the beliefs the teachers' held. While the two White participant science teachers promoted the cultural and ethnic differences of their school and saw themselves on the forefront of teaching culturally diverse student populations, they both strongly held a belief that kept them from considering the cultural diversity of their students during almost all of their pedagogical decision-making. The teachers strongly held the belief that they should think of their international and African American students as the same as their White students when making pedagogical decisions. This belief was contained in the analytical categories They Are All Kids To Me (In School) for Mrs Guide and They Are All Kids To Me (But the Black Kids Do Distinguish Themselves) for Mr Green. The teachers did not want to emphasize their students' differences in class because they believed that would lead to promoting separatism. The result was that they consciously aimed at not having their pedagogical decisions influenced by the students' cultural and ethnic backgrounds. They justified their belief in student universalism by claiming that since their students were in their science classes in their city, county, state, country, the students made the decision to learn science the way it was traditionally taught in that social context.

The social-contextual analysis recommended by Charron (1991) and others (Ogbu, 1981; Peshkin, 1991; Wilcox, 1982) asserts that "social beings and events are so closely tied to their surroundings as to be inseparable in real life as well as for research purposes" (Charron, 1991). A social-contextual analysis conducted offers a tempting insight in

understanding the participant science teacher's strong fear of promoting 'separatism' by considering their students' cultural and ethnic differences when making pedagogical decisions.

The state, county, city, and school in which the research was conducted has a history of separation between two ethnic groups, Whites and African Americans. Less than 35 years ago, separation of the two ethnic groups was both a legal and accepted social practice. Segregation was a distinguishing feature of the public education systems, and integration of the state's public schools came only after the U.S. Supreme Court decision in Brown vs. Board of Education of Topeka. Even then, it was enacted only through the federal government's continual insistence in this state years later. Segregationists in the state's Education Association endorsed "Separate but equal" schools in 1955. 'Separatism' is now generally associated with racism in this state. Treating all students the same, no matter how diverse their backgrounds are, and only separating them according to ability (e.g. giftedness) indicated by standardized tests is considered the safest professional stance for teachers today in this state's schools. Therefore, considering students' cultural or ethnic backgrounds, even when the intent is to more fully acknowledge their different characteristics to assist with more effective science education instruction in pedagogical decision-making, suggests 'separatism' and should be avoided.

The teachers' belief that they should not consider their students' cultural and ethnic backgrounds also fits in well with teacher's time honored pattern of practice to 'be fair' and not to favor any one student over another and not to discriminate against one student over another.

Alan Peshkin (1991) also found in his year-long ethnographic study of teachers in a culturally diverse school high school in California that they "disregard[ed] ethnicity at the same moment that they clearly ha[d] it in mind" (p.129). Peshkin argued that the teachers in the school were more or less left on their own to devise a way to teach their culturally diverse students, so they taught their culturally diverse students in the way that best fit the teachers' view of teaching and learning in this country. The result was they taught all students as if they were of the same cultural and ethnic background and held views of "universalism, assimilation, and color-blindness" (p.154). This kept the teachers from explicitly asking: "Does student ethnicity constitute a fact with instructional consequences?" (p.265). The participant science teachers in this study did hear that question from the researcher and answered with a strong "No." It was observed, however, that in isolated instances during teaching that one or the other participant teacher did make pedagogical decisions described by the multicultural issues English as a second language, cultural lifestyles, and overt acknowledgement of student differences.

Another question investigated in the course of the study was the following:

**2. What pedagogical decisions do science teachers in multicultural classes make on a daily basis?**

Summary: The two participant teachers' daily pedagogical decision-making was categorized. In both teacher's cases, the choices were binary in structure. The pedagogical decisions they made, with the exception of consideration of the language difficulties of ESOL students, did not contain a multicultural component that addressed the diversity of the students in their classes.

Discrete analytic categories emerged for Mrs Guide's during-teaching decision-making. In Oral or Visual, Mrs Guide made the choice between presenting information to her students through an auditory technique (e.g. lecture or teacher statement) or through a visual technique (e.g. notes on board or on overhead transparency). In Provide the Answer or Make Students Find the Answer, Mrs Guide made the choice between telling her students an answer or eliciting from her students an answer. In Consider Student Questions or Avoid Student Questions, Mrs Guide made the choice between focusing on student questions during the lesson or avoiding discussion of student questions. In Use Class time or Save Class time, Mrs Guide made the choice between using class time for an activity she perceived as valuable or saving class time by not pursuing an alternative strategy. In Emphasize Content They Need to Get or Let Them Identify the Content They Need to Get, Mrs Guide made a choice between highlighting content that she thought was important and should be learned, or not pointing out information to her students that was important, thus placing the responsibility on her students to identify it as important. In Make Allowances For Students' Ability Differences or Treat All Students the Same, Mrs Guide made the choice between recognizing student ability and language differences and acting accordingly or treating all students the same in ability and in language skills.

Discrete analytic categories emerged for Mr Green's during-teaching decision-making. In Jump Straight Into It or Advance Organize It, Mr Green's choice was between whether he should start his lesson with his students by jumping straight to the science content he planned to teach or to start his lessons by placing his daily objective on the greenboard and requiring his students to copy it into their notebooks as a type of advance organizer. In Teacher-

Centered or Student-Centered, Mr Green's choice was between whether he would make his lesson teacher-centered (i.e. lecture, direct students to read from their textbooks, or instruct students to fill in worksheets) or student-centered (i.e. use cooperative student learning groups in an activity, have students discuss topic in whole class question-answer technique, or have students make presentations to the class). In Ride That Wave or Nip It in the Bud, Mr Green's choice was between sticking with his structured lesson plan or to diverge from his lesson plan and pursue concerns that his students brought up during instruction periods.

Another question investigated in the course of the study was the following:

**3. What sources of information do science teachers use to select pedagogical strategies and then implement them through pedagogical decisions?**

Summary: The participant teachers gave their rationales for selecting and implementing pedagogical strategies. Information they used to select and implement their pedagogical strategies varied. Primarily, both participant teachers selected and implemented pedagogical strategies to teach the district's objectives in a timely manner which fit their vision of how students best learn.

In selecting and implementing pedagogical strategies, Mrs Guide relied on her nine years teaching experience with middle school students and her extensive familiarity with teaching resources. Her decisions related to: sequencing the topics; selecting specific lessons

and activities; selecting films and videos. She used the student textbook as an additional source of life science content. The school calendar, of course, served as the starting point in scheduling lessons and assessments.

Mrs Guide believed that students best learned life science through cooperative learning experiences, so she selected and implemented as many hands-on activities as possible. Sources included the curriculum guide, education courses she attended, other teachers' lessons she observed, professional teacher journals, and teacher conferences and workshops.

Mrs Guide used information on her students also before selecting and implementing pedagogical strategies. She considered the ability of her students to complete assignments within a certain length of time; she considered their attitude toward an assignment (but would not let their dislike of a task necessarily stop her from giving it to them); and she considered language difficulties of international students.

During teaching Mrs Guide selected and implemented pedagogical strategies based on the following information: the social skills she wanted her students to master; her understanding of teachable moments; the amount of time she allocated in the lesson/unit to cover the district's objectives; what her students would be accountable for on assessment tasks; and her students' language ability.

After teaching, Mrs Guide used the following information to select and implement future pedagogical strategies: its match with her lesson plan; an identification of any unexpected decisions that needed to be made during instruction; and what she learned from the lesson.

Before teaching, the information Mr Green used to select pedagogical strategies were the district's required earth science objectives, the time of the year which best fit the district's objectives, and safety procedures.

During teaching, the information Mr Green used to implement pedagogical strategies were his experience with getting his students started on a lesson, the lesson evaluation guidelines his administration used, his supply of hands-on activities, his repertoire of teaching strategies, his understanding of teachable moments, and the language abilities of his students. Mr Green shared Mrs Guide's belief that students best learned science by being actively involved in cooperative learning groups.

After instruction, Mr Green assessed his class performance with three questions. The questions were: (1) How can I generate greater student interest; (2) How can I make the class move more smoothly; and (3) How can I make laboratory procedures safer?

The final question investigated in the study was the following:

**How does the cultural and ethnic background of the teacher influence the decisions made by the teacher in a multicultural classroom?**

Summary: This provocative question proved tantalizing but unanswerable in this study since neither of the teacher participants explicitly associated their cultural or ethnic backgrounds with specific pedagogical decisions they made in their culturally diverse classrooms. It was evident to the researcher, however, that the teachers' culture and ethnicity factored in their world views. Both Mrs Guide and Mr Green comfortably referred to themselves as White Americans. Mrs Guide and Mr Green felt pride in their culture and promoted Americanization for their students. They believed their students and parents

supported Americanization by choosing to attend their public middle school. Mr Green identified himself as a "male Southern American" and thought his international students could become American if they wanted, but never Southern Americans. Mr Green believed his students would have to be born in the south and then adopt southern customs to be considered "Southern."

Although the degree to which these factors impacted the teachers' pedagogical decisions was too complex to isolate here, it is the researcher's opinion that their cultural and ethnic backgrounds played a part. Like Peshkin (1991), the researcher believes that ethnicity

> has significance in its own right [but] separating it significance from social class, age, gender, interests, and aspirations is more than I can do...Ethnicity is present without determining. Like an unseen hand, it leads and guides, but always in the company of other factors (p.282).

**Interpretation**

A theory developed in sociology and anthropology offers insight toward developing grounded theory in this study. "Rules of conduct" Collett (1977), describes how rules that govern individuals' behavior are created and enforced in cultures. Individual actions are shaped, guided, and constrained by culturally agreed upon rules that guide individuals' conduct. Rules are agreed upon norms of conduct passed down generation to generation in a community. An individual's actions are evaluated by other members of the culture through consideration of if the person knows or does not know the rules and through consideration of if the person's behavior does or does not accord with the rule. The identification of rules is performed through interpretation of actions of many members of a community. An example of a special rule of conduct in most cultures is the incest taboo (Fortes, 1983).

A hypothesized rule of conduct that filtered the conduct of the two participant science

teachers' decision-making before-, during-, and after-teaching was "Fair play." Treating students fairly was perceived by the teachers as requiring them not to discriminate against individual students due to their ethnic or cultural backgrounds. As a result, the acknowledgement of the students' differences was restricted to their academic ability (as indicated on formal assessment tasks) and their motivation demonstrated in class. Students' cultural and ethnic differences were considered potential areas of discrimination and were not included in pedagogical decision-making. Figure 1 presents a provisional schema of the participant teachers' decision-making filtered by the rule of conduct fair play.

Secada (in press) offers an encouraging insight into teacher decision-making that relates to this hypothesis. Secada states that most teachers hold a belief in social justice founded on equality, instead of equity, which causes them to treat all students the same. He believes that teacher decision-making will not change unless teachers' perspective of social justice is founded on equity, instead of equality, which will cause them to consider treating students differently to more appropriately meet the needs of different students.

INFLUENTIALITY OF DECISION MADE WITH MULTICULTURAL EDUCATION AS FILTER
TEACHER ACTIONS
RITUAL INSTRUCTION-ACTION PRACTICES
One responsive actions that provided insight into the mores of teaching held by the teachers.
For example:
Mrs Guido:
Assist students in learning science vocabulary
Mr Green:
Minimize teacher exposition and maximize student activity
DECISION-MAKING INSTRUCTION PRACTICES
BEFORE-TEACHING
classroom environment
science unit planning
individual lesson planning
DURING-TEACHING
(idiosyncratic binary categories)
For example:
Mrs Guido: Provide the answer or make the students find the answer
Mr Green: Hide that word
or slip it in the bud
AFTER-TEACHING
evaluation of lesson
MULTICULTURAL EDUCATION FACTORS RECOMMENDED BY THEORISTS
COGNITIVE AND AFFECTIVE FACTORS
e.g. Western and Non Western Ways of Knowing; Styles of Learning; Gender Related Attitudes Toward Science; Locus of Control and Motivation; Career Expectations
CLASSROOM ENVIRONMENT FACTORS
e.g. Student Interactions; Social and Emotional Climates; Group vs. Individual Achievement
ASSESSMENT AND EVALUATION FACTORS
e.g. Standardized or Individualized; Ability Grouping or Mixed classes
TEACHER KNOWLEDGE FACTORS
e.g. Cultural groups (history, culture, and contributions
TEACHER BELIEFS AND VALUES FACTORS
e.g. Expectations of students, empowering students
COMMUNICATION PATTERN FACTORS
e.g. Standard English or non-standard English; body language, auditory or visual
TEACHING METHOD FACTORS
e.g. Use of mixed cooperative learning groups, learning by doing, non competitive activities
CURRICULUM FACTORS
e.g. community based curriculum, detection of biases
RULE OF CONDUCT FILTER: FAIR PLAY
Fair play Defined By Teachers: social justice founded on equality.
Teachers Beliefs That Supported the Rule of Conduct:
Mrs Guido:
They are all kids (in school)
Mr Green:
They are all kids (but the Black students do distinguish themselves)
School Communication Code That Signified The Rule of Conduct:
Code of Contradiction.
Students' diversity extolled in social sphere; students' diversity not acknowledged in teaching/learning sphere
MULTICULTURAL EDUCATION FACTORS INCLUDED IN DECISION-MAKING BY PARTICIPANT TEACHERS:
BEFORE TEACHING
Mrs Guido:
Classroom Environment Factors
Distribute mainstream and non mainstream students throughout seating chart (supported)
Communication Pattern Factors
Emphasize language assistance for Limited English Proficient students (supported)
Mr Green:
Classroom Environment Factors
Assign Limited English Proficient students seats together (not supported)
DURING TEACHING
Mrs Guido:
Communication Pattern Factors
Give Limited English Proficient students multiple opportunities to answer oral questions (supported)
Pick school/class as reference point for examples (supported)
Teaching Method Factors
Establish mixed heterogeneous cooperative learning groups (supported)
Mr Green:
Teacher Knowledge Factors
Use student suggested science example that focused on one ethnic group (supported)
Communication Pattern Factors
Allow Limited English Proficient students to work together in cooperative learning group (not supported)
AFTER TEACHING
Mrs Guido: None
Mr Green: None

Figure 1: Provisional schema of participant teachers' decision-making

Actions taken to address teachers' rules of conduct directly impacting on their teaching of diverse students will necessarily have to be systemic across the areas investigated in this study. The social contexts in which teachers work need to encourage multicultural teaching practices. The promotion of a multiethnic society valuing cultural pluralism instead of the promotion of an assimilationist or melting pot society must exist. The perspective of the learner, encouraged by the constructivist epistemology, must place emphasis on an understanding of how the learners' cultural and ethnic background influences the learning field in addition to an appreciation of the learner's prior subject knowledge. And, the perspective of how to teach the subject matter should be based on a pedagogical content knowledge identified in teachers' teaching practices that include multicultural considerations.

Tables are attached that provide summaries of the teachers' decision-making, proposed cultural mores of teaching, and ritual instructor action practices.

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Table 1

Participant Science Teachers' Before-Teaching Decision-Making

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**Category One: Classroom Environment Decisions**

Mrs Guide

Classroom Decor
Arrangement of Student Desks
Placement of Students

Mr Green

Classroom Decor
Arrangement of Student Tables
Placement of Students

**Category Two: Science Unit Planning Decisions**

Mrs Guide

1. Time of year to teach topic.
2. Use of past lesson plans, resources.
3. Use of films and videos.
4. Lesson days.
5. Assessment days.

Mr Green

1. Time of year to teach units.

**Category Three: Individual Science Lesson Planning Decisions**

Mrs Guide

Evaluation of the lesson
What she learned from the lesson

Mr Green

Evaluation of the lesson

Table 2

Participant Science Teachers' During-Teaching Decision-Making

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Mrs Guide

D-M Instructor Practice Analytic Categories

Oral or Visual
Provide the Answer or Make Students Find the Answer Consider Student Questions or Avoid Student Questions
Use Class time or Save Class time
Emphasize Content They Need to Get or Let Them Identify Content They Need to Get
Make Allowances For Students' Ability Differences or Treat All Students the Same.

Multicultural Issues

English as a Second Language
Gender
Diverse Culture
Ethnic Group

Mr Green

D-M Instructor Practice Analytic Categories

Jump Straight Into It or Advance Organize It
Teacher Centered or Student Centered
Ride That Wave or Nip It in the Bud.

Multicultural Issues

English as a Second Language

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Table 3

Participant Science Teachers' After-Teaching Decision-Making

Mrs. Guide

Evaluation of Lesson

- Did it match lesson plan?
- Did unexpected decision-making interrupt the flow of the lesson?
- How will this experience influence future lessons?
- Was the assessment appropriate?

Mr Green

Evaluation of Lesson

- Were the students interested?
- Did the lesson proceed smoothly with no accidents?
- Was the assessment appropriate?

Table 4

Mrs Guide's Ritual Instructor-action Practices (I-Action Practices)

1. She gives oral command to students to pay attention to her.
2. She points out Life Science content as important: this will be on test.
3. She uses an overhead transparency of gymnosperm.
4. She gives an Canadian African American male student a transparency to copy from at desk while she continues giving notes to class with another transparency.
5. She points out differences between angiosperm and gymnosperm on transparency.
6. She uses oral questioning of students to get content answer she wanted.
7. She points out important content to students.
8. She makes sure students have notes copied.
9. She suggests that students work together to complete assignment.
10. She tells students that they know what cotyledon is; to the less knowledgeable, she suggests they can say seed leaf.
11. She tells students she is not competent to judge their art work, just competent to judge them in Life Science.
12. She uses a lesson on listening to point out that some students were not listening.
13. She allows an African American female student and other White female student to put hands on their heads, heads on desk as she lectures.
14. She refers to a lab students had earlier in year.
15. She tells students they were going to copy notes from transparencies. A Canadian African American male student (slow copier) puts head down and teacher places hand on his shoulder and says, 'It is OK; you can do it.'

16. She asks students to come up with list of food items they have not tasted before. She thinks students are getting off task with discussion and ends discussion.

17. She defines "olfactory" for students.

18. She writes the name of videos on board for students to copy.

19. She asks students to read facts they wrote down while watching videos. She repeats their answers.

20. She announces before going over homework assignment that she is aware some students had trouble with it. A student gives a word for word definition of a science process. She gives an everyday explanation.

21. She takes an Asian Indian male student's textbook answer and breaks it down into smaller components to help the students understand it.

22. She uses a leaf to show the parts that the vocabulary words describe. She asks students a question about cuticle and gets three answers. The first two are listened to but the third answer is announced by her to be correct.

23. A Canadian African American male student reads definition of xylem and phloem to class. Teacher hints that is important information and they will see it again on test question.

24. She reminds students before they watch a video that they have studied this content earlier in the year in Life Science.

25. She reads class lab directions word for word before lab.

26. She places students in lab groups with 4 members.

27. She admonishes White male student that there is a right and a wrong way of picking up a microscope in class.

28. She is called over to a small student learning group and views their slide. Says, "Wow," smiles and moves on to next group.

29. She asks students to give definitions of ecology.

30. She asks students a question. An African American female answers it.

31. She asks students if their clothes are biotic or abiotic.

32. A Puerto Rican female asks what "i.e" means. Teacher answers, 'For example (sic),' and says it is a word used in scientific work.

33. She asks what the students have learned about ecology and its parts.

34. She compares level in ecology with the classroom or the school.

35. She uses classroom to discuss interdependence concept.

36. She asks students what criteria they could use to group themselves. Students suggest race, gender, eye color, and hair color.

37. She asks how they would group themselves according to race.

38. She makes the analogy of the class as a population. Asks students to explain what happens to them if they are not successful. Those not successful are banished.

39. She reads the laboratory directions to the class.

40. She tells the class that an earlier class was able to find 5 or 6 of the organisms on the ID sheet in the pond water.

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Table 5

Mrs Guide's Cultural Mores For Teaching Life Science

1. The teacher should provide assistance with students' learning of science vocabulary through various strategies--using diagrams showing what the words represent, repeating words, writing words on greenboard, defining words in everyday language. *(#3, #5, #10, #17, #18, #20, #21, #32)

2. The teacher should make sure students get the same content and that she emphasize that it be the basis for students' assessments. (#2, #4, #7, #8, #19, #23)

3. The teacher should allow students to demonstrate their knowledge. (#29, #30, #31, #33, #37)

4. The teacher should use and encourage student examples in her instruction that contain common student experiences at school. (#32, #35, #36, #38)

5. The teacher should intervene to stop off task behavior. (#1, #16, #27)

6. The teacher should receive correct content answers from students for her questions. (#6, #22)

7. The teacher should encourage students to do well in class. (#13, #28)

8. The teacher should give detailed directions for students in new activities. (#25, #39)

9. The teacher should try to point out connections between concepts. (#14, #24)

* correspond with numbers identifying ritual instructor-action practices listed in earlier table.

Table 6

Mr Green's Ritual Instructor-Action Practices

1. The teacher gives students quiz written on overhead transparency. He talks with two international students and tells them to do their best. He allows the ESOL students to use their textbook during quiz.

2. The teacher collects quizzes and goes over answers one at a time.

3. The teacher gets answers from students in a tag-team strategy (first student answers, the teacher calls on second student to respond to what first student said, and so on).

4. The teacher asks students to tell him what they were going to do in the lesson after they discuss daily objective.

5. The teacher answers Asian female student question about assignment.

6. The teacher requires his students to write up the lab as a homwork assignment.

7. The teacher tells students how to get most out of activity by modelling how to use the equipment.

8. The teacher reviews procedure before lab.

9. Before starting lab, The teacher tells students to wear safety glasses.

10. The teacher models safety procedure by wearing goggles during the lab and lights all alcohol burners.

11. The teacher moves from small group to small group during lab.

12. The teacher helps international students (he explains the procedure and monitors their safety).

13. The teacher allows students to pick their own small groups.

14. The teacher works with international students during lab. He works personally with the male international student group.

15. The teacher debriefs students at end of lab to pull the class together after unstructured experience (lab).

16. The teacher selects male Italian-American to give weather report.

17. The teacher assesses prior knowledge of students by asking their prior experience with natural phenomenon.

18. The teacher selects female African American student to tell what she thought about science concept.

19. The teacher checks students' homework by individually talking with them at their seats as his students watch a video.

20. The teacher allowed student to hang a purple sign on wall that contains letters in muslim language for "Mr Green."

21. The teacher listens to a student statement, then turns that statement into a question.

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Table 7

Mr Green's Cultural Mores For Teaching Earth Science

1. The teacher should minimize teacher exposition and maximize student centerness of class through manipulative experiences, teacher-student communication, and oral reports. *(#3, #5, #16, #17, #18, #19, #21)

2. The teacher should be aware that ESOL students should be taught differently than language proficient students (by placing them together and by allowing them to use written resources on assessment tasks). (#1, #12, #14)

3. The teacher should structure students' lessons by requiring them to copy a daily objective into their notebooks and by modelling laboratory experiences before students participate in them. (#4, #7)

4. The teacher should teach science by using cooperative groups because scientists work in groups and because students in groups get a better chance of talking with the teacher individually. (#8, #11)

5. The teacher should let students have the most freedom possible in class (e.g. by allowing them to pick their own cooperative group members and sit where they want) because that makes them happy and happy students work in class. (#13, #20)

6. The teacher should monitor students carefully in lab for safety concerns. (#9, #10)

7. The teacher should help all his students restructure knowledge to the correct scientific view by going over each assessment item by item in class. (#2)

* correspond with numbers identifying ritual instructor-action practices listed in earlier table.